



HARVARD
CHEMISTRY
CLUB

GUIDE TO CH₃MISTRY

2022-2023

Dear chemistry enthusiast,

Welcome to chemistry at Harvard! We are so excited to show you the myriad courses and advising resources offered here and hope that you are able to find what you are looking for within the department. We know that there are so many paths people could take on their journey to exploring their passion for chemistry. Hopefully this guide, which contains information on potential concentrations, research opportunities, student perspectives on math and science courses, and student groups you may consider joining, will help you during your first year at Harvard College. If you continue to have questions or concerns, we hope that you will feel comfortable reaching out to any of us on the Chemistry Club board. We also welcome you to all the Harvard Chemistry Club socials and events to meet more concentrators and become a part of the Chemistry community at Harvard. We are so excited to meet all of you and can't wait to hear from you!

Warmly,

The Harvard Chemistry Club

hchemistryclub@gmail.com

CHEMISTRY CLUB BOARD

2022-2023

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Class of 2024

ellendeng@college

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Class of 2023

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Social Chair

Class of 2024

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eionchua@college

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PREFACE

This year's Guide to Chemistry has information that is accurate to the best of my knowledge on August 4, 2022. While I hope this continues to be useful for the whole academic year, guidance or course information that is relevant now may not be in a few months, especially due to the ever-changing nature of university restrictions and the balance of virtual versus in person opportunities. If you have any questions or want updated information, please email me or anyone else on the Chemistry Club board!

Have a great start to the semester,

Benjamin Tang

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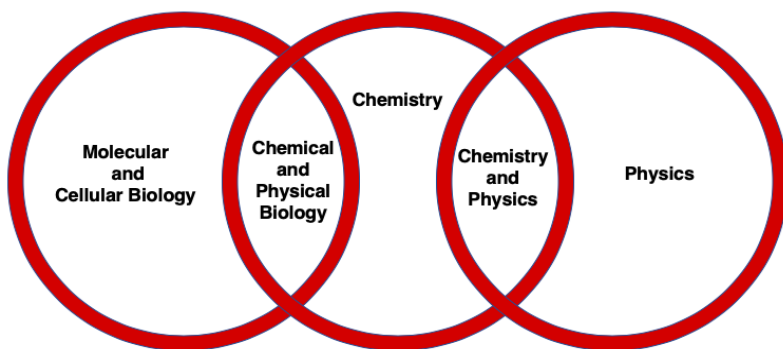
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§1 Concentrations

Students declare concentrations in their third semester, and even after that, it's easy to change your concentration. For more information about concentrations, check out the department websites and the online Harvard College Handbook at handbook.fas.harvard.edu/book/fields-concentration.

It's important to research the requirements for concentrations and schedule advising meetings about concentrations you're curious about. That said, there is no rush to decide on a field in your first and second semesters. In fact, it's more dangerous to box yourself into a concentration on day one. Be open-minded, try new things, take classes that interest you, and ask lots of questions.

Chemistry is the main concentration offered by the Department of Chemistry and Chemical Biology (CCB), but the department sponsors two other concentrations that involve collaborations with other departments. **Chemical and Physical Biology** is the intersection of CCB and the Department of Molecular and Cellular Biology (MCB). Likewise, **Chemistry and Physics** is the intersection of CCB and the Department of Physics.



Three Departments; Five Concentrations

§1.1 Chemistry

Dr. Gregg Tucci, DUS¹
tucci@fas.harvard.edu

Dr. Tucci is the academic advisor for all chemistry concentrators. He co-teaches PS11 and LPS A (see §2.2) and is the best resource for any student with questions about chemistry at Harvard. If you think you might be interested in doing chemistry during your time at Harvard, whether it's taking a class, doing research, or concentrating, you will benefit from meeting with him – he is a fantastic resource and will approach all of your questions with a smile on his face!



The chemistry concentration is designed to prepare students in various future endeavors, whether medical school or graduate chemistry work, or anything in between. There is no single correct way to progress through the concentration requirements (they're flexible on purpose!), and there is the opportunity to tailor your experience to your interests at every step. Research is highly emphasized and while the concentration is thesis-optional, many chemistry students engage with research during their time here.

¹ DUS, Director of Undergraduate Studies; ADUS, Assistant or Associate Director of Undergraduate Studies.

§1.2 Chemical and Physical Biology

Dominic Mao, ADUS

dominicmao@fas.harvard.edu

Professor Adam Cohen, Co-Head Tutor cohen@chemistry.harvard.edu

Professor Rachelle Gaudet, Co-Head Tutor gaudet@mcb.harvard.edu

If you're browsing the various biology concentrations, you may feel lost in the alphabet soup of acronyms. CPB is the closest thing to Biochemistry that Harvard offers, and students take most of the same requirements as Chemistry concentrators, along with some required MCB and computational courses. The concentration is thesis-optional, but offers a tutorial program to establish mentors in the MCB department and emphasizes the importance of research from the beginning.

§1.3 Chemistry and Physics

Professor Howard Georgi, Co-Director of Undergraduate Studies

georgi@physics.harvard.edu

Dr. David Morin, Co-Director of Undergraduate Studies

morin@physics.harvard.edu

The Chem/Phys concentration is strong preparation for graduate research in the physical sciences and a great way to marry two very compatible fields. Chem/Phys requires four courses in chemistry and four courses in physics, which makes it easy for both Chemistry and Physics students to switch into Chem/Phys. Unlike Chemistry, Chem/Phys requires the Physics 15 sequence (see §3.4). Chem/Phys concentrators are also automatically eligible for honors consideration – there's no need to follow a special honors track like in the Chemistry or Physics concentrations.

§1.4 Secondary Field in Chemistry

A secondary field (minor) in Chemistry is a great way to get chemistry skills while concentrating in something else in the College. The 6 courses required are very flexible, and with a little planning, won't burden you as you navigate your main concentration. Whatever your future plans, we want to have you in the department! Chemistry is for everyone and having some experience is a valuable asset.

Concentrations in Other Departments

§1.5 Molecular and Cellular Biology

Professor Vlad Denic, Head Tutor vdenic@mcb.harvard.edu

MCB is intended for students who are interested in pursuing careers in cellular biology research or medicine and for those who wish to combine interests in chemistry, physics, and math through the study of cellular processes. It is considered a popular pre-med concentration because it overlaps well with many of the med school requirements.

§1.6 Physics

Professor Howard Georgi, Director of Undergraduate Studies
georgi@physics.harvard.edu

Dr. David Morin, Co-Director of Undergraduate Studies
morin@physics.harvard.edu

Physics is for students who are interested in studying the way the world works, from the Big Bang to the “bizarre” relativistic and quantum mechanical regime of objects. Physics concentrators are required to take a reasonably small number of courses, which makes the concentration very flexible. As a result, many students choose to do joint concentrations such as Physics & Mathematics, Physics & Astronomy, and Physics & History of Science. Additional flexibility is provided by the Physics options in Biophysics, Applied Physics, and Teaching.

§2 Courses in Chemistry and Related Fields

§2.1 Remarks on Courses

As the course offerings and professors change frequently, we encourage you to speak with multiple people about your selection: concentration advisors, proctors/tutors, professors, teaching fellows, upperclassmen, and other members of the Chemistry Club. Be sure to check with the online Handbook (handbook.fas.harvard.edu) to figure out what courses are necessary for your concentration or secondary. Additionally, as the start of the semester approaches, available courses and course lecture times may be subject to change. Be sure to frequently look at the courses on my.harvard.edu to stay up to date on course offerings.

Q Guide and Explorance Blue

Frankly, this isn't as helpful as it used to be. The online Q Guide (q.fas.harvard.edu) is the student evaluation tool, where you can read through candid student opinions and advice about courses from different semesters back about a decade. It features comprehensive metrics about workload, quality of teaching, and lots of other information. Students take the Q Guide very seriously, and reviews can often sway your decision on whether to take a class or not. The Q guide previously operated on a separate website, but starting in Fall 2019, Harvard moved the Q Guide onto a new platform called Explorance Blue – same general format, but information was scarier because nothing before Fall 2019 was transferred.

Additionally, the new Q guide often times lacks students' comments on the class, which was by far the most useful type of information on the website. Moving forward from Fall 2021, we anticipate that courses will differ significantly from Fall 2019 and 2020 and previous Q scores. Q scores that may still be relevant can include professor ratings, difficulty ratings, and student reviews on the teaching staff. If you can navigate the two websites (old Q and Explorance Blue), feel free to take a look, but know that the information there might not apply anymore.

Freshman Seminars

Freshman seminars can be a great way to know a professor and expose yourself to new fields of interest. These courses are Pass/Fail and the professor are really enthusiastic about the material that you are covering and getting to know the students in the class. Because of this, freshman seminars can make transition to academic life in college easier for first-years. Almost every department in the College, including the chemistry and other science departments, offers at least one freshman seminar.

Take advantage of freshman seminars if you have a particular interest in a professor or in a particular course subject. You could even take a freshman seminar during both your fall and spring semesters! But keep in mind that freshman seminars are not required, so if none pique your interest, you can opt out.

Summer Courses

Harvard College does not offer summer courses, but undergraduates can take classes at the Harvard Summer School, sometimes for concentration credit. Summer school is becoming more relevant, as Harvard begins to offer it as a “makeup” for remote learning.

The summer semester is only 7 weeks long, making it about double the pace of a normal semester. Since it’s intensive, most people only take one class, so one can devote more attention to it. Many students will also take a summer class in addition to doing summer research or a summer on-campus job. Always check with your advisor before enrolling to make sure the credit will be applied to your transcript. CHEM S-17: Organic Chemistry is one of the most popular for-credit summer school classes taken by Harvard students.

Breadth

It may seem like everyone you talk to knows what they want to study already. You may feel like you are the least-prepared person on campus, and that you just wound up here for some reason.

Conversely, you might have known that you wanted to be a chemist since middle school. You may have planned out your chemistry plan of study already, and you might feel like Harvard’s next top chemist.

Both of these people should take one or maybe two chemistry classes in their first-year fall. Being able to appreciate the humanities and the sciences alike, wanting to pursue multiple interests, and generally being multidimensional are all qualities that liberal arts colleges, including Harvard, want their students to possess. With access to over 3000+ course offerings, you don't want to feel regretful in your eighth semester that you never even looked at 30-or-so departments' course offerings. It's in your best interest to try lots of different things and keep an open mind during your time here!

§2.2 GENERAL CHEMISTRY

"Where is Chem 1? Or even Chem 101?"

Harvard doesn't always name or number their courses intuitively, especially introductory courses. Nor does it offer a two-semester general chemistry sequence like many other schools. Instead, future chemists are integrated with future biologists for at least one semester before they take courses that begin with "Chem." If a course starts with "LS" (Life Science), you can expect some combination of chemistry and biology. If a course starts with "PS" (Physical Science), it could really be anything.

Chemistry concentrators are nominally required to take two general chemistry classes chosen from LPS A, LS1a, PS1, PS10, and PS11. That said, it is common to only take one general chemistry course and take an additional advanced course later to make up for it. Two pairs of classes—LPS A and LS1a, and PS1 and PS11—are mutually exclusive; they cover the same material from different angles. If you choose to take LPS A, it must come before any other chemistry class. None of these classes assume anything past high school chemistry and are typically targeted towards freshmen or sophomores with less background in chemistry.

LPS A: Foundational Chemistry and Biology

[FALL] LPS A (Life and Physical Sciences) is an alternative to LS1a for students with less of a chemistry background. As such, the class material is heavier on chemistry for about $\frac{2}{3}$ of the semester, but progresses into its biology applications much like LS1a does. LPS A boasts smaller class sizes than LS1a and is a great way to meet Professor Tucci early on and get a feel for science at Harvard. LPS A counts for exactly the same requirements as LS1a does and many students go on to take LS1b in the spring (there is no LPS B).

LS 1a: An Integrated Introduction to the Life Sciences: Chemistry, Molecular Biology, and Cell Biology

[FALL] LS1a is an integrative chemistry and biology course, a pre-med requirement, as well as a foundational course for many future biology and chemistry concentrators. The course is co-taught by professors Dan Kahne and Rachelle Gaudet. Professor Kahne covers the chemistry concepts (about the first $\frac{1}{3}$ of the course) while Professor Gaudet teaches the biological applications. LS1a is a great choice for anyone thinking about studying science, and because of its broad scope, it counts for several concentrations. Traditionally one of the larger fall courses, LS1a has a huge support structure for students including peer study leaders (PSLs), teaching fellows (TFs), and preceptors in addition to the two professors. After LS1a, many students go on to take LS1b (see below), but this is only required for CPB concentrators. Pre-med concentrators can also choose to take LS1b to fulfill one semester of the biology requirement.

PS 1: Chemical Bonding, Energy, and Reactivity: An Introduction to the Physical Sciences

[SPRING] The difference between PS 1 and PS 11 is not obvious, and the two seem to compete for students as they're usually held at the same time in adjacent Science Center lecture halls. Not all chemistry students take either course, but they are as close to "GenChem" as Harvard offers. PS 1 presents pure chemistry without frills: an introduction to quantum mechanics, chemical bonding, acid/base chemistry, equilibrium, thermodynamics, electrochemistry, and a unique section on semiconductors. Because of this, PS 1 is usually a smaller class than PS 11, which makes accessing the professors easier. The chemistry presented in both courses, however, is largely the same and comes at a similar pace.

PS 11: Foundations and Frontiers of Modern Chemistry: A Molecular and Global Perspective

[SPRING] Like PS 1, PS 11 also offers general chemistry, but aims to make it relevant to life in the 21st century. This course is attractive to

those who would otherwise find general chemistry dry, since everything is applied to our world today (climate change, energy sources, etc.) and features "50 Globally Relevant Questions." Because of this angle, PS 11 often enjoys higher enrollment than PS 1, even though the chemistry they teach are almost completely equivalent. Prof. Anderson and Prof. Tucci receive high praise for the class, though its large size is sometimes an obstacle to a lot of 1-on-1 interaction. PS 1 or 11 are great courses to take in the spring of your first-year, though there are upperclassmen in both classes.

PS 10: Quantum, Statistical, and Computational Foundations of Chemistry

[FALL] Though it counts as general chemistry, PS10 is an intensive introductory course that establishes a foundation in physical chemistry. While many undergraduate programs save physical chemistry for after organic chemistry, PS10 is a great way to get a taste of chemistry classes that would occur after O. Chem in an easily accessible manner. The first half deals with quantum chemistry (see Chem 160) and the second half introduces statistical thermodynamics (see Chem 161). Students gain early experience in MATLAB, which becomes useful for upper-level classes, and perform some computer modeling projects. The class culminates in a final paper with a poster session during finals week. This class is usually significantly smaller than other general chemistry courses with a class size of about 15 students, which makes for lots of individual attention and is great for getting to know your peers.

§2.3 ORGANIC CHEMISTRY

Chemistry concentrators are required to take two organic chemistry courses, without much exception. There are two organic chemistry tracks: Chem 17/27 and Chem 20/30. 17 and 27 have larger class sizes with an orientation towards biology/pre-medical students, while 20 and 30 are smaller and offer pure chemistry and synthesis. Both tracks are counted equally under the chemistry concentration (and pre-med requirements), and while you cannot take both 17 and 20, students can take both 27 and 30, since they cover significantly different material. If your goal is to ever do research in chemistry, then synthesis-oriented 20/30 is the right choice. If you want to apply organic chemistry to biology, then 17/27 is better. Be careful, though! It is difficult to switch tracks once you've decided, since Chem 20 is only offered in the spring, and Chem 17 only in the fall!

Both sequences are intense, rigorous and a very rewarding introduction to organic chemistry. Learning organic chemistry is not easy! Like a language, it requires lots of practice and an organized approach. The course staff supplies many resources—plentiful office hours, extra reviews before exams, a plethora of practice problems—and your peers will provide you with lots of moral support. You will be astonished by how much you have learned by the end of each class.

Chem 17: Principles of Organic Chemistry

[FALL] Chem 17 is the first semester of organic chemistry tailored to chemistry and biology students. The vast majority of students in this course are sophomores, and it's usually a very large class that appeals to pre-med students. Contrary to the O. Chem/Orgo stereotype, Chem 17 does not "break" students, and its reputation is overall pretty tame. Chem 17 is in some ways a continuation of LS1b, as you will find most of the same cohort of students in both courses, and Chem 17 builds on LS1b's material. In introducing functional groups, arrow pushing, and some basic reaction mechanisms, this class is similar to Chem 20, but the material is tailored to be relevant to students with a biology background and a biology future. There is no lab component.

Chem 20: Organic Chemistry

[SPRING] Chem 20, taught by Professor McCarty, is the first semester of organic chemistry tailored to chemistry and physics students. It is frequently the class that chemistry students cite as the best class they've taken due to the engaging lectures, well-structured course materials, and passionate teaching staff. It introduces reactions, mechanisms, and syntheses and is a pedagogical gem. This course is made up of a mix of first-years and sophomores and is small enough to really create a good community of students. Whether it inspires you to keep taking chemistry or makes you realize it's not for you, the study skills from Chem 20 will serve you in whatever further courses you take. Chem 20 usually has a four-hour lab every two weeks.

Chem 27: Organic Chemistry of Life

[SPRING] Chem 27, taught by Professor Balskus, is a continuation of Chem 17, and most students take the two courses back-to-back in their sophomore year. It's organic chemistry applied to biological processes (think Krebs cycle). The class limits itself to biologically-relevant reactions and like Chem 17, the majority of exam questions are about reaction mechanisms with no synthesis questions. It is not related to Chem 30, and the two classes cover very different material. Chem 27 is the closest to undergraduate biochemistry that Harvard offers. It also includes a significant lab requirement (traditionally, four hours/week).

Chem 30: Organic Chemistry

[FALL] Chem 30, taught by Professor Myers, is a continuation of Chem 20 and is taught in a similar fashion. A marathon of reaction mechanisms is presented, pushing into pericyclic and organometallic chemistry in the last third of the course. Synthesis questions are given a lot of weight in this class. Chem 30 is regarded as a difficult class for everyone, but its reviews are consistently very high. Your diligence will pay off, and Chem 30 sets you up for success in any graduate level organic chemistry course. Additionally, by the end of the semester, you will be able to see synthetic pathways when presented with an organic molecule. Chem 30 usually has a four-hour lab every two weeks.

Chem 100r: Experimental Chemistry and Chemical Biology

[FALL/SPRING] Chem 100r, taught by Professor Vollmer-Snarr, is an advanced lab course in organic chemistry (it replaced Chem 135, if you ever see that on a course listing). One advanced lab course is required of concentrators between 100r, 145, and 165. Chem 100r is the most popular choice of the three and is open to any student who has completed organic chemistry. In this course, you'll be assigned a grad student mentor and embark on a research project under their supervision, typically committing ten hour/week to lab. The class culminates in a full research report. Students gain a better understanding of analytical tools like TLC, NMR, UV-VIS, IR, and LC/MS and work on presentation skills. In normal semesters, the class takes a trip to Washington, D.C. to present science advocacy posters to members of Congress.

§2.4 INORGANIC CHEMISTRY

One semester of inorganic chemistry is required for chemistry concentrators, and Chem 40 is one of the few classes that virtually every concentrator takes.

Chem 40: Inorganic Chemistry

[SPRING] Chem 40 is almost better titled “Chemical Philosophy” because much of it includes presenting arguments for why you might characterize a molecule a certain way. You’ll get an introduction to symmetry, group theory, coordination chemistry, and learn more on organometallics. Chem 30 prepares you well for the class since much of the organometallic material is repeated, though students coming out of Chem 27 also do just fine. The majority of students in this class are sophomores and juniors. Three professors rotate teaching Chem 40: Prof. Betley, Prof. Nocera, and Prof. Mason, so it’s never the same class twice. Prof. Betley will be teaching the class in Spring 2023.

Chem 145: Experimental Inorganic Chemistry

[FALL] Chem 145, along with Chem 100r and Chem 165, is an advanced lab course that introduces modern inorganic lab techniques that use the concepts you learn in Chem 40. This course has a guided research project that involves a proposal, experiment, analysis, and presentation. If you liked Chem 40, Chem 145 is a great way to apply what you learned through infrared (IR), Electron Paramagnetic Resonance (EPR), paramagnetic and Nuclear Magnetic Resonance (NMR), and electronic absorption spectroscopies; and electrochemical techniques. Beyond lab techniques, students will also gain experience reading, writing, and analyzing scientific literature.

§2.5 PHYSICAL CHEMISTRY

Two semesters of P. Chem are required of Chemistry, CPB, and Chem/Phys concentrators alike, though Chem/Phys students have the option of fulfilling the requirement through the chemistry or physics departments. The most standard path through P. Chem is Chem 160 and Chem 161, taken any time after you have completed general physics and math.

Chem 160: The Quantum World

[FALL] Chem 160, is a course in quantum mechanics for chemists and for many an introduction to physical chemistry. The details of bonding, vibration, and rotation are investigated, and the course provides the “why” to the behaviors of electrons, atoms, and molecules. Some of the basic ideas will be familiar if you took PS10, but this class has a decidedly computational focus with MatLab simulations forming the backbone of the problem sets. This also sets it apart from the physics analogue Physics 143a, which covers quantum mechanics in a more mathematically rigorous way. Chem 160 is required for Chemistry concentrators and counts for the chemistry requirements of CPB and Chem/Phys (though Chem/Phys students might opt for Physics 143a.)

Chem 161: Statistical Thermodynamics

[SPRING] Chem 161 is the follow-up to Chem 160 and deals with advanced thermodynamics and kinetics. It emphasizes chemistry-specific applications of statistical mechanics. As in all classes, be sure to take advantage of office hours. In combination with Chemistry 160, it covers all the major topics of physical chemistry well and is the standard way to complete the physical chemistry requirement. Either Chem 60 or 161 is required for Chemistry and Chem/Phys concentrators (though many Chem/Phys students will take the physics analogue of this class: Physics 181).

Chem 165: Experimental Physical Chemistry

[SPRING] Chem 165, along with Chem 100r and Chem 145, is an advanced lab course in physical chemistry that presents experimental techniques from the theory you learn in Chem 160. Computer-based data acquisition is emphasized. If you enjoy the content of Chem 160, then Chem 165 is a great option to continue working with P. Chem.

§2.6 ADVANCED CHEMISTRY

After taking the introductory and basic undergraduate classes, consider taking the more advanced 100-level classes in the department. These are offered both to undergraduate and graduate students, and many can be taken as extensions of undergraduate courses. For instance, [Chemistry 105: Advanced Organic Chemistry](#) expands on material from the Chem 20/30 sequence at a graduate level, and [Chemistry 154 and 155: Advanced Inorganic Chemistry](#) expand on Chem 40.

Other classes may focus on more specific topics in chemistry research that are of high interest today. Often, professors will teach classes closely related to their own research, so taking these classes are an excellent way to learn from a leading expert in his or her field. Be sure to check the course catalog frequently or ask Dr. Tucci what 100-level courses are being offered if you're interested.

These advanced courses are often taught once every two years (or even less frequently!) If a specialized course catches your eye, know that it might not come back during your time here!

There is also the opportunity to cross-register for an MIT class if a class on a subject not taught by the department at Harvard seems interesting to you. Cross-registration is admittedly somewhat rare among chemistry students, and is especially complicated in the current situation, but if you are interested you need only fill out the necessary petition on the Course Catalog online. Be sure to talk to Dr. Tucci to see how the class will fit with your concentration or secondary requirements.

§2.7 BIOLOGY

Biology is only required of CPB concentrators, though biology classes will count towards electives for Chemistry concentrators. Many concentrators also take these classes to fulfill pre-medical requirements.

LS 1b: An Integrated Introduction to the Life Sciences: Genetics, Genomics, and Evolution

[SPRING] LS 1b serves as an introductory course for many biology concentrations. It is offered during the spring term, and it is most often taken by first-years following LS 1a or LPS A. However, it's not uncommon for some students to take the course during the spring of their sophomore year or even later, since it's not required for Chemistry (but IS required for CPB!). The course's main focus is to provide students with a solid understanding of the role of genetics and genomics in the evolution of life as well as teaching new ways of understanding and treating many diseases from the organismic to the population level. This is a popular pre-med class that retains much of its structure and student population from LS1a.

MCB 6o: Cellular Biology and Molecular Medicine

[FALL] MCB 6o is the gateway course for CPB and MCB concentrators. Many Chemistry concentrators will also take it as an elective or for a medical school requirement. MCB 6o is an integrated introduction to molecular, cellular, and developmental biology in the context of biomedicine and scientific discovery. In contrast to most introductory course lab requirements, MCB 6o's weekly lab component gives the students investigational freedom, more accurately simulating a real research experience. After MCB 6o, students have a host of intermediate courses to choose from, ranging from biochemistry to cellular biology; for CPB students, one intermediate course is required after MCB 6o.

§2.8 PHYSICS

CPB and Chemistry concentrators are required to take two physics courses, and there are lots of ways to meet this requirement, from rigorous physics that will prepare you for graduate work (15 sequence) to an MCAT-conscious sequence meant for future doctors (PS 2 and 3). Chem/Phys students have to take at least four courses and their options are more limited but go further into the field. All Chemistry concentrators will find it will be helpful to have completed the physics requirement before they start P. Chem.

PS 2: Mechanics, Elasticity, Fluids, and Diffusion

[FALL] PS 2 is mechanics for pre-medical students, taught with the MCAT in mind. Always a large course, the student body is all non-physics concentrators— in fact, Physics and Chem/Phys students don't get credit for it! Pre-medical students usually take physics their junior year (so as not to overlap with O. Chem), but there are a good mix of sophomores and seniors in the class too. PS 2 and 3 actually cover more topics than Physics 15a and 15b, but less in-depth. PS 2 has lecture, section, and lab, and covers concepts of kinematics, work, energy, rotation, SHM, and a large section on fluid dynamics and diffusion. The goal of PS 2 and 3 are for students to learn physics without the pressure of competing for grades— you'll find these courses very generous.

PS 3: Electromagnetism, Circuits, Waves, Optics, and Imaging

[SPRING] PS 3 is a continuation of PS 2 and teaches electricity and magnetism, targeted towards pre-medical students. While PS 2 is nominally a prerequisite, a number of students take PS 3 first, and the course staff is very accommodating of out-of-sequence students. PS 3 has identical format to PS 2 (lecture, section, and lab) and covers electricity, magnetism, logic gates, light rays, lenses, waves, and sound. Calculus makes a brief and avoidable appearance.

PS 12a: Mechanics and Statistical Physics from an Analytic, Numerical and Experimental Perspective

[SPRING] PS 12a is mechanics for students concentrating in science or engineering fields who want some kind of mathematical and computing rigor to their physics experience. Some Python background is definitely recommended; no coding experience will have you playing catch up from the start. The course covers roughly the same general material as PS 2 and Physics 15a, and PS 12a is not meant for Physics concentrators— it's aimed at first-years exploring engineering. Single-variable calculus is assumed.

PS 12b: Electromagnetism and Quantum Physics from an Analytic, Numerical and Experimental Perspective

[FALL] PS 12b is the continuation of PS 12a for students looking into the engineering sciences, covering E&M similar to PS 3 and Physics 15b. While 12b is meant to come after 12a, some sophomores will take 12b in the fall and 12a the following spring. This is a possible move, but definitely take care in doing so! It will be assumed that you are familiar with the kind coding work required for 12a. Topics included are electricity, magnetism, circuits, optics, and some quantum mechanics.

PHYSICS 15a: Introductory Mechanics and Relativity

[FALL/SPRING] The Physics 15 sequence are the introductory physics courses for Physics and Chem/Phys concentrators. It includes three courses, where other sequences contain only two, and all three courses are offered in both fall and spring semesters. Physics 15a covers mechanics and some special relativity with calculus at the level of Math 1b (students are required to take at least Math 1b concurrently and encouraged to take Math 21a concurrently). A large majority of 15a students are first-years and sophomores, many of whom will go on to take advanced physics classes later in their career. There is weekly lab. The well-defined structure of this course receives consistent praise from students, and Professor Morin (for Fall 2020) is also highly regarded as a lecturer. Like any science class, working with peers is highly recommended on homework and practice problems. The Physics

department sponsors several events a week, including Physics Night (usually in Leverett, now in Jefferson) where students and TFs come together to work on physics problems (Our advice: come to Physics Night with the p-set largely finished so you can just check it!). See also our friends at the Harvard-Radcliffe Society of Physics Students and [this FAQ](#) about introductory physics courses. The bottom line is, if having a strong physics foundation is something that is important to you, the 15 sequence is for you.

PHYSICS 15b: Introductory Electromagnetism and Statistical Physics

[FALL/SPRING] Physics 15b is the second course in the rigorous Physics 15 sequence. It covers E&M with calculus at the level of Math 21a, so it's advised to have already taken 21a (some students take it concurrently). The structure of this course is nearly identical to 15a, the only differences being a different professor (there is no set professor of 15b) and a new math requirement. Again, the class is made up of mostly first-years and sophomores and there is another weekly lab requirement.

PHYSICS 15c: Wave Phenomena

[FALL/SPRING] Physics 15c is the third and final course in the rigorous Physics 15 sequence. It covers all types of oscillation and resonance with math at the level of Math 21b, so it's advised to have already taken 21b (some students take it concurrently). The structure of this course is again nearly identical to 15a and 15b, with a new professor and a more advanced math requirement. Since only two semesters of physics are required for Chemistry concentrators, some do not take 15c, but the three courses are designed to be taken as a trio and forgoing 15c will leave you with an incomplete overview of general physics.

PHYSICS 16: Mechanics and Special Relativity

[FALL] Physics 16 is an alternative course to Physics 15a. The material is broadly the same as 15a, but with a significantly higher math expectation. Physics 16 is the real deal: think of it as adjacent to Math 55. Frankly, few Chemistry students take this course, since it's designed for

entering first-years with rather strong math and physics backgrounds. However, a decent amount of Chem/Phys students do take this course, and many really enjoy it. After Physics 16, students usually take Physics 15b or Physics 153.

PHYSICS 153: Electrodynamics

[SPRING] Physics 153 is the advanced version of Physics 15b for students who enjoy having more of mathematical approach to learning E&M. Students should know, or at least be able to brush up on, vector calculus in multiple dimensions. The material covered for the first part of the course is similar to Physics 15b, but there is much more depth later on, and it moves at a faster pace. Not many Chemistry students take this course, but it is common for Chem/Phys students to enroll and enjoy themselves in the more rigorous environment.

PHYSICS 143a: Quantum Mechanics I

[FALL/SPRING] Physics 143a is the first part of a two-semester long series that delves into the Quantum world. It assumes students have background in classical mechanics, E&M, and wave phenomenon. The mathematical rigor of the course also means students should have an understanding of linear algebra. The professor teaching has changed over the past few iterations, and students from all classes have taken the class.

PHYSICS 143b: Quantum Mechanics II

[FALL] Physics 143b is a continuation of the material taught in Physics 143a with a focus on path integrals, identical particles, many-electron theory, WKB approximation, time-dependent perturbation theory, scattering theory, relativistic quantum mechanics, and basics of quantum information. Students who complete this course often times go on to high level Quantum classes.

APPHY 50a: Physics as a Foundation for Science and Engineering, Part I

[FALL] Applied Physics 50a is a small, lotteried, experiment-based course that teaches mechanics through group projects rather than lecture. The course is aimed at engineers and not many Chemistry concentrators take this sequence, but the option is always there. While switching between the 2/3/12/15 sequences is common, it's assumed that you'll stay in the yearlong ApPhy 50 sequence. Math at the level of multivariable calculus is used.

APPHY 50b: Physics as a Foundation for Science and Engineering, Part II

[SPRING] Applied Physics 50b is the continuation of 50a. The course structure is identical, and the material covers electricity, magnetism, Maxwell's equations, and optics.

§2.9 MATH

CPB and Chem/Phys require math to the level of linear algebra, while Chemistry only requires multivariable calculus. While the most common path involves the Math 1a/b and 21a/b courses, your math career is something that can be very individualized, and there are a lot of different paths to choose from. Keep in mind that your math placement score is likely a conservative diagnosis of your skills. Math is a very popular joint degree or secondary field program with Chemistry concentrations. We present a tiny slice of popular introductory math courses here, but the Math Department holds lots of very helpful advising sessions during the first few weeks of classes. Check out a full list of math courses [here](#).

Math Ma: Introduction to Functions and Calculus I

[FALL] Math Ma and Mb are introductory math classes for students with no calculus background. Together, they are the two-semester alternative to Math 1a.

Math Mb: Introduction to Functions and Calculus II

[SPRING] A continuation of Math Ma. Students go on to take Math 1b from here.

Math 1a: Introduction to Calculus

[FALL/SPRING] Math 1a (Calculus 1) is a large class in the fall, and a small class in the spring. It serves as an introduction to calculus for students without a strong calculus background, or who want a review of differentiation and integration that will serve you well if you go on to take Math 21a.

Math 1b: Calculus, Series, and Differential Equations

[FALL/SPRING] Math 1b (Calculus 2) is a large class split up into small sections in both semesters. It begins with integration techniques thrown at you quickly, then moves into convergence and divergence, Taylor series, and an introduction to differential equations that will serve you well if you go on to take Math 21b.

Math 19a: Modeling and Differential Equations for the Life Sciences

[FALL] Math 19a is an alternative course to Math 21a specifically geared towards life science concentrators. The math you learn is applied towards modeling biological concepts (population studies and disease progression, for example). Taught by Professor Cain (who is highly praised), this course includes a final project instead of a final exam, and consists of usually about 20 students. 19a is a great option for students who want to see their math directly applied to the field they're studying, and satisfies the math requirement for Chemistry. Math 19b also exists (spring only) and deals more with statistics for the life sciences.

Math 21a: Multivariable Calculus

[FALL/SPRING] Math 21a (Calculus 3) is the most popular course for Multivariable Calculus and is split up into several small sections in both fall and spring. You'll learn about vectors, the dot and cross products, parametric curves, partial derivatives, Lagrange multipliers, double and triple integrals, and integral theorems like Green's and Stokes.

Math 21b: Linear Algebra and Differential Equations

[FALL/SPRING] Math 21b (LinAlg) is the most common follow-up to Math 21a. While a large course both semesters, it's more popular in the spring than in the fall. You'll learn about everything matrix and Eigenvalue related, and the last third of the class is devoted to applying what you've learned to solving differential equations. From here, you're qualified for advanced 100-level math and applied math courses.

Other Math Courses

Some other course numbers you might hear are 18, 22, 23, 25, and 55. The latter four involve writing proofs and are geared towards students interested in pure math. Math 18 is analogous to Math 19, but for the social sciences instead of the life sciences. The Math Department anticipates students' confusion about all the different offerings, so never be shy about asking which course is right for you.

§2.10 MISCELLANEOUS

LS 50a/b: Integrated Science

[FALL + SPRING] LS 50 is a full year, 8 credits/semester course for the most driven of life science first-years. Meant to integrate math, physics, chemistry, biology, and some computer science, LS 50 is a beast of a class that will certainly be the main event of your first two semesters. It knocks out several requirements, including math, chemistry, and biology, and is an alternative to more traditional general chemistry and general biology. If you have LS 50 in your plan, remember that it takes up the space of 2 classes each semester with weekend lab requirements.

Chem 91r, 98r, and 99r: Research for Credit

[FALL/SPRING] Doing research during your time here at Harvard is highly recommended in any field. But especially in chemistry, an authentic research experience will be a huge asset to you (see §4)! Some people do research as volunteers, others get paid through grants, and others do it for credit. If you are already involved in a faculty lab, or have a reading project with a faculty member in mind, you can take Chem 9#r (the “r” stands for repeatable, meaning you can take each course twice) and get 4 SAT/UNSAT credits each semester. Talk to Dr. Tucci if you are interested! 91r is for sophomores, 98r is for juniors, and 99r is for seniors. All three are exactly the same and none are prerequisites for the others.

§2.11 Sample Course Tracks

Something that can be helpful is looking at real-life course tracks our concentrators have taken in their first two years, flaws and all. Note that there are no two alike paths through college and we only show courses that count for their Chemistry concentration.² We encourage you to take some calculated, advised risks and remember, Harvard is here to serve you—not the other way around!

That said, a talk with Dr. Tucci is always a good idea. He can guide you through your options and make sure your plan of study checks all the boxes, while still being exciting and tailored to you.

Student A -	Chemistry		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	LS 1a Math 21a	Fall	Chem 17 PS 12b Stat 110
Spring	LS 1b PS 11 Math 21b	Spring	Chem 27 PS 12a Stat 111

² We also include Statistics, which isn't required, but very common for students to take.

Student B -	Chemistry		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	LS 1a Math 1b	Fall	Chem 30 PS 2
Spring	Chem 20 PS 1	Spring	Chem 40 PS 3 Math 21b
Summer	Math 21a	Summer	Chem 100r ³
Student C -	Chemistry		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	PS 10 Math 22a	Fall	Chem 30 Physics 15a
Spring	Chem 20	Spring	Chem 40 PS 3
Summer	_____	Summer	Bios S-10 ⁴

³ Called Chem S-101 in the summer, though it is the exact same class.

⁴ A summer-only class called "Introduction to Biochemistry" to fulfill the biochemistry requirement, since this person took neither LS 1a nor Chem 27.

Student D -	CPB		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	Math Ma LS 1a	Fall	Chem 17 MCB 60 Math 1b
Spring	Math Mb LS 1b PS11	Spring	Chem 27 MCB 64 ⁵ Math 21a
Student E -	CPB		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	LS 50a	Fall	MCB 60 MCB 169 ⁶ Physics 15a Stat 110
Spring	LS 50b MCB 68 ⁷ Math 21a	Spring	Chem 20 MCB 65 ⁸

⁵ MCB 64: Cell Biology in the World

⁶ MCB 169: Molecular and Cellular Immunology

⁷ MCB 68: Cell Biology Through the Microscope

⁸ MCB 65: Physical Biochemistry: Macromolecules, which counts for CPB's P. Chem. requirement.

Student F -	Chem/Phys		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	LS 1a Math 21a	Fall	Chem 30 Physics 15a Stat 110
Spring	Chem 20 PS 11 Math 21b	Spring	Chem 115 Chem 100r Physics 15b
Student G -	Chem/Phys		
<i>First-Year</i>		<i>Sophomore</i>	
Fall	Physics 15a Math 22a ES 53 ⁹	Fall	Physics 15c Chem 30 Stat 110
Spring	Physics 15b Chem 20 Math 22b	Spring	Physics 143a Chem 40 Chem 27
Student H -	Chemistry Secondary		
<i>First-Year</i>	LS 1a	<i>Junior</i>	Chem 101 Chem 100r
<i>Sophomore</i>	Chem 17 Chem 27	<i>Senior</i>	PS 11

⁹ ES 53: Physiological Foundations for Bioengineering (a SEAS engineering course).

§3 Science Resources

§3.1 Academic Resources

Once you begin the school year, at times, you may find yourself overwhelmed with coursework. It is helpful to know the resources available to you so that you can reach out when you need it. To this end, there are several offices and places you can go for academic counseling, advice and tutoring.

Academic Resource Center (ARC)

academicresourcecenter.harvard.edu
academicresourcecenter@harvard.edu
(1414 Massachusetts Avenue, Floor 3R)

The ARC is an invaluable resource for Harvard students. As a part of your extended advising network, they hold workshops and lessons on how to study, develop more effective reading strategies, and hone your time management skills. They also run a peer tutoring system, provide academic coaches, and run accountability groups: it's like professional development for students. The ARC offers both remote and in-person sessions and is always ready to help.

Math Question Center

The Math Question Center (MQC) is a space where students come to work together on math homework and get questions answered from older students who serve as Course Assistants. Your math course heads will provide more details, but MQCs are held nearly daily in the Science Center.

Professors, Preceptors, and Teaching Fellows

Never be intimidated to meet with instructors! Especially after times of remote learning, they *want* to meet you. Whether you have questions about the course material, need clarification on some feedback you got, or just want to talk about their field, **instructors are the single most valuable resource to you during your time here!** They

are what differentiates a Harvard education from any other program. Plus, developing relationships with professors is a great way to get into doing research, finding summer opportunities, and generally fostering a great relationship with an incredibly accomplished person.

Teaching fellows' (or "TFs", who are usually graduate students) office hours are an extremely efficient way to learn all the new material hurled at you in a typical science class. Regularly attending TF office hours all but ensures success in a course—no matter the subject. Get all of your questions answered here, from questions about problem sets, course materials, or exams. TF office hours can also be a great place to connect with other students enrolled in the course, since they are often less formal than meeting with instructors. Talking to TFs is another great way to learn more about research opportunities on campus, and TFs will often write recommendation letters for summer applications.

Other Students

A personal anecdote from one of our Presidents: he *never* collaborated on work in high school; it was always faster to figure it out alone. But during his first semester in LS1a, he noticed he was receiving lower homework grades than all of his friends. After feeling dumb for a few minutes, he approached them and asked if they could spend 15 minutes together cross-checking their completed work. They pointed out his mistakes to him, and it turned out that he wasn't dumb after all, because everyone had been working together or getting help in some capacity.

It is thus important to note: very few people are able to successfully complete a p-set alone on their first try!

Professors always expect you to write-up your problem sets independently, but most allow and even encourage students to get together and discuss their homework, do practice problems, and study for exams. That said, always familiarize yourself with the Academic Integrity Policy for every class, and never be afraid to ask your instructor about gray areas.

In science courses, working with other students is usually critical to doing well. Get to know the students sitting around you in your classes! Most likely, they will be the same students in your classes next

semester, and the semester after that, and often, close friendships will soon form!

§3.2 Student Academic Groups

A great way to meet people who share your interests is to learn more and join some of Harvard's many student groups. We've listed a few here, but know that there are clubs for just about every interest!

Harvard Chemistry Club

The Harvard Chemistry Club is a student organization dedicated to connecting members of the Harvard chemistry community. If you are a Chemistry, CPB, or Chem/Phys concentrator, a secondary field candidate, or are simply interested in chemistry, we want you to join! (Joining entails adding yourself to the email list).

The Chemistry Club hosts events with faculty and socials, including speaker series, poster sessions, sushi dinners, and socials with other organizations! Virtually, we held student panels on summer opportunities, online speaker series, and Jeopardy! nights. We provide a strong network for you to meet other people interested in chemistry, which is especially necessary with most students off-campus. Meet upperclassmen, get advice, and be a part of chemistry at Harvard! Visit hcs.harvard.edu/chemclub.

IG: @HarvardChemClub

Harvard-Radcliffe Society of Physics Students

SPS is the analogous student organization for the Harvard physics community. They hold socials and other activities much like Chemistry Club, and also have a weekly speaker series called Chilloquium every Monday at 4:30 ET, where faculty and other invited guests give a short lecture. Especially for Chem/Phys students, SPS membership is a great way to meet other physicists! Visit <http://www.hcs.harvard.edu/~physics/>.

Harvard College Undergraduate Research Association

The Harvard College Undergraduate Research Association (HCURA) aims to increase the scope and visibility of all undergraduate research by building an interdisciplinary research community that engages in projects that enrich the undergraduate research experience. This is facilitated through peer research advising; discussions and symposia for faculty and students; and the organization of an annual Life Sciences Undergraduate Research Fair, Visitas Research Symposium, and the National Collegiate Research Conference (NCRC), the largest student-run undergraduate research conference in the country. HCURA also publishes the science magazine *Brevia*.

Environmental Action Committee

The Environmental Action Committee aims to promote sustainability and environmental practices in order to benefit the Harvard, Cambridge, and global communities. They promote environmentalism through educational outreach, campaigns about food, events, as well as our environmental art publication, The Canopy. www.hcs.harvard.edu/~eac/

Harvard Society of Black Scientists and Engineers

The Harvard Society of Black Scientist and Engineers (HSBSE) seeks to provide support for, and foster a sense of community among, Black Harvard students pursuing degrees in the life sciences, engineering, the applied sciences, and other STEM fields. They also seek to promote the social standing of Black students in science and engineering, as well as offer career advising, professional development workshops, and assist in job placement. Furthermore, they strive to serve as mentors and tutors to encourage STEM education in the wider Cambridge community, combatting underrepresentation in the sciences by facilitating the growth of Black scientists at every level.

Harvard Women in Chemistry

Housed in the CCB department, HWIC is an organization for graduate students and undergraduate students alike. It is a great way to

connect with women studying Chemistry at Harvard, especially if you are an undergraduate interested in attending graduate school in the future. HWIC has regular formal and informal events to connect students and faculty.

This past year, Harvard Chemistry Club and HWIC launched the inaugural **Womxn in Chemistry Mentorship Program (WiCheM)**, where undergraduates and graduates are paired based on shared interests and are encouraged to share career and academic advice. The highly reviewed program boasts nearly 60 participants, and hosts game nights, spotlight series, and sponsored ice cream walks for participants. The program is gender inclusive and we encourage everyone to sign up this fall!

Check out the HWIC website to keep updated with their upcoming events. Visit <https://hwpi.harvard.edu/womeninchemistry>.

Women in STEM Mentorship Program

Run by the Harvard Women's Center, this program pairs undergraduates with graduate or medical student mentors. In addition, the program hosts monthly WiSTea gatherings, where mentor and mentee pairings can meet up over tea and cookies and also interact with faculty members in various STEM departments that are invited as well. This program is a great program to apply to if you're looking for extra guidance and a solid community of other womxn in STEM.

§3.3 Job Opportunities

There are a lot of job opportunities on campus, many of which are organized through the Student Employment Office and the Office of Career Services. Many students work part-time in libraries, department offices, Dorm Crew, or as course assistants! Paid research is also available (see §4). Some remote jobs are available this year; looking through the jobs database of the SEO is a great way to find opportunities.

Student Employment Office

www.seo.harvard.edu
(617) 495-2585
86 Brattle Street

The SEO provides students with numerous research and job opportunities. Whether it be through work-study programs or research programs, the SEO is definitely the place to go if you're looking for a job on campus. If you're interested in research, the SEO provides many different types of awards to fund projects both on and off campus.

Office of Career Services

www.ocs.fas.harvard.edu
(615) 495-2595
54 Dunster Street

The Office of Career Services helps students in making academic and career decisions. They are very good at coaching students on interview skills, resume-writing skills, etc. They can also direct you as you look for internships or other summer and post grad opportunities.

TF/CA/PSL Jobs

- TF - Teaching Fellow (graduate or advanced undergraduate)
- CA - Course Assistant (undergraduate, more responsibilities)
- PSL - Peer Study Leader (undergraduate, fewer responsibilities)

Generally, before each semester starts, some course heads will reach out to previous students and send out applications for TF or PSL positions for the following semester. If you have taken Math 21a or an equivalent course, you are eligible to apply to be a CA for any math course equivalent to or below what you have taken already. Not only do these teaching jobs pay well, but they also provide an amazing opportunity to pass on your knowledge to other students while simultaneously allowing you to solidify your understanding of the material as well.

Summer Jobs

Although there are many opportunities available through on-campus programs, we also encourage you to look outwards. If you know you have specific research interests, it may be helpful to reach out to advisors and mentors who you know have experience in that field and can point you in the direction of opportunities that are available to you (see *Professors, Preceptors, and Teaching Fellows*). Dr. Tucci is a great person with whom to start a conversation about summer opportunities.

§4 Conducting Research

Most students try research at some point during their time at Harvard — either during the summer or over the school year. Some students start as first-years, others their senior year, and many more somewhere in between. If graduate school is something that interests you, then doing research as an undergrad will be a great way to get some experience in a lab setting. Doing research is applying everything you've learned in class!

Meet with Dr. Tucci if you're interested in starting research!

§4.1 Beginning Research: A Q&A.

1. *"What if I'm not qualified?"*

It's not expected to have any research experience before college. Professors are very much aware of this, and a huge part of research is in-lab training with a graduate student or postdoctoral student. The most important skill for an undergraduate to possess is the ability to *engage with other students in the lab* and *be passionate about your research!* You're not expected to know much, but you are expected to ask questions.

2. *"When should I start research?"*

You should start research when you genuinely want to do so. Some students start early to get more experience quickly and be able to stay with a research group for several years. Other people wait until much later, after they've taken lots of classes, have a favorite field, and are more prepared for understanding the chemistry content. It doesn't quite matter when you start; it matters more that you are excited about it when you do.

As for the time of year, don't rush the process of joining a lab! Early January (for beginning in the summer) and late May (for beginning

in the fall) are excellent times to ask so that lab administrators have time to coordinate your entry into the lab.

3. *"If I've found a group that I'm interested in, how do I join?"*

There is no standard application process to join a lab, and every professor has their own way of dealing with undergraduates. The best thing you can do is meet with Dr. Tucci with your thoughts. He knows every professor personally and can give you tailored advice for contacting each one.

One general requirement is knowing what kind of work the lab does. You can figure this out by reading papers from the lab, and browsing the lab website. In general, the joining process might include an initial email (or several emails), a resumé, an interview, and maybe attending weekly group meetings for a bit, but again, it's different for everyone. The most important and ubiquitous advice is showing genuine enthusiasm for the subject.

In addition, Anna Babakhanyan, the life sciences research advisor, is a great resource! Whether you're looking for someone to help look over your science resume (or help you write one), connect you with PIs (principal investigators) and labs via email, or ask about funding, she is extremely knowledgeable and helpful.

Anna Babakhanyan

Undergraduate Science Research Advisor
ababakhanyan@fas.harvard.edu

4. *"I'm pre-med. How does research fit in with my plans?"*

In applying to medical schools, just as it was applying to college, there is no magical formula. Many people accepted to medical schools have participated in research, and there is also a significant number of people who have never held a test tube outside of their pre-med lab classes. If you want to go to medical school, the most important skills to have are those involved with being a good doctor, and that doesn't

necessarily mean having done research. Especially if research isn't your thing, consider other activities that you may enjoy. Do what you like, and show your personality; medical schools will appreciate this!

If you like research, definitely pursue it. Any type of research is fine, as long as you enjoy it. Again, medical schools don't really care specifically what you have done and in what area. They are just looking to see that you are doing something, and that you have a passion for what you are doing.

5. "I've got my own research idea. What can I do?"

Great! Harvard specifically provides funding for students wanting to do research through the Harvard College Research Program. Detailed information can be found on the SEO website. This is an especially wonderful program to keep in mind during your upperclassman years. To apply for the funding, you would need to have developed a detailed research proposal to be reviewed by the committee, and thus this option is generally more applicable after your introductory science courses. It is generally for students who have a deep understanding of their research interests and are working under the guidance of a professor. If your idea is well developed and thorough, the committee will be very willing to provide students with funding up to \$1000 per semester.

§4.2 Summer Research Opportunities

Summer is a great time to get involved in research; without that crazy school schedule, you'll be able to fully immerse yourself in a project and make solid progress. The most important aspects (besides finding a position in a lab) are getting 1. housing and 2. funding. Here we'll discuss a few sources of funding provided by Harvard's Office of Undergraduate Research and Fellowships (URAF). Harvard Chemistry Club will also host a panel during Wintersession where upperclassmen will discuss what they pursued during the summer and any advice they may have. For more comprehensive information about research fellowships, please visit uraf.harvard.edu.

With independent research funding, URAF gives you money, and you do your own research (you're in charge of finding a lab/project). You can get the funding from the Harvard College Research Program (**HCRP**) with similar requirements as the term-time HCRP (see §4.3). This research must be in a Harvard-affiliated lab. A similar but much more competitive program is the **Herchel Smith Fellowship**, which typically awards a stipend of at least \$4,800 for research that can be anywhere in the world. This program aims to attract undergraduates who want to pursue a Ph.D. in the natural/physical sciences and/or mathematics, so the application process echoes some aspects of the graduate school application process.

The URAF also offers great residential research programs, which have a fun "summer camp" vibe. For example, the 10-week long Program for Research in Science and Engineering (**PRISE**) provides housing in a river house, weekday HUDS dinners, a stipend of approximately \$3000, and most importantly, lots of activities for the community. PRISE really emphasizes community-building among a group of motivated undergraduate scientists from all disciplines, backgrounds, class years, etc. To facilitate social interaction, PRISE *generously* funds its fellows to propose and lead most of the summer's activities. From screaming at Six Flags, to hiking the White Mountains, to tasting chocolate at Taza factories, you're guaranteed to have a phenomenal time. On the academic side, you get to find your own project in a Harvard-affiliated lab, and the program holds a seminar series given by distinguished Harvard professors, workshops on scientific communication and post-grad opportunities, etc. The program culminates in an abstract session, where fellows will present their research in a final 15-20 minute presentation.

The URAF allows ambitious students to do both PRISE and Herchel Smith during the same summer but note that they will reduce your Herchel Smith stipend by ~\$1,200 and withhold the PRISE stipend.

§4.3 Term-Time Research

Although more hectic than doing research over the summer, term-time scientific research is a rewarding experience if done correctly. This section will address the student perspective of conducting term-

time research. You can get additional information at lifesciences.fas.harvard.edu/research.

1. *"How many hours per week am I in the lab?"*

This largely depends on how time-consuming your project is. Many people find that they spend anywhere from 10 hours to 20 hours per week in the lab. Before an exam, students might avoid lab work altogether, while during weekends and breaks, you might work a little more (if you're around Cambridge).

Be prepared, however, to spend 3-4 hours or so every week meeting with your PI, attending group meetings, and meeting with any non-faculty advisers you might have. Because lab work in college is usually self-motivated, and there is less pressure to publish, students usually feel free to work on their own schedules.

2. *"How should I budget my time if I want to do term-time research?"*

If you know you're going to be doing term-time research, find your research group's calendar and try to schedule their weekly group meeting as if it's a class. Planning your schedule to contain large blocks of open time can also be a smart idea, because chemistry experiments often take more time to run. Or you can decide to mostly work on the weekends. Also, try to have a general idea of your class schedule before scheduling regular update meetings with your PI.

3. *"Where can I find academic credit or funding for term-time research?"*

During the school year, you have the option of working in a Harvard lab as a volunteer, for class credit, or for pay.

Chem 91r, Chem 98r, and Chem 99r (see §2.10) are 4 credit, SAT/UNSAT classes that can be used to get credit towards degree requirements by doing research with any professor in the department or other PIs, with the permission of Gregg Tucci.

For undergraduate research funding opportunities, check **CARAT** (carat.fas.harvard.edu). One of the most common sources of term-time research funding is the Harvard College Research Program

(HCRP). The application process requires writing a proposal and a budget, so some idea of what you sort of research you will be conducting over the term is necessary. Term-time funding can reach a maximum of \$1,000.

§5 Final Remarks

§5.1 Advice from Current and Former Students

On Choosing a Path:

For many freshmen, you will hear peers and advisors encouraging you to concentrate in what interests you and what sparks an academic passion. I agree to the extent that you want to at least enjoy what you are learning. To be honest, a couple of classes in a concentration is not and should not be representative of your experience in that entire concentration. There will be fantastic and “meh” classes in every concentration.

- Yue Ren '16

Never hesitate to ask faculty, especially Gregg, questions about the different concentration options or your academic and life goals in general. They are always willing to help and offer advice! I originally came in thinking that I would concentrate in Neurobiology. Chemistry wasn't even on my radar. Then, I took PS11 and talked to Gregg Tucci about the class and my academic interests. He suggested that I shop some upper level Chemistry courses the next fall semester to see if they interested me. After shopping some classes and taking Chem 17/27, I knew that Chemistry was the right concentration for me.

- Ji Hae Lee, '20

You could say that I'm a late bloomer when it comes to concentrating in Chemistry. When I started I was hard set on concentrating in a Bio and doing premed. I realized after my freshman spring that this was not what I really wanted to do. However, during the course of those first two semesters I took the basic

requirements that would also count for Chemistry (i.e., LS1a/b, Math 21a, PS11). If you think you're too late to do Chemistry or that you'd have to build up a foundation in order to take Chem classes, don't be afraid to do that at all.

- Christopher Johnny, '18

Keep an open mind. Don't be discouraged because of rumors you have heard. Don't be scared, because you might not realize how much you enjoy something unless you try it. Believe it or not in high school I hated Chemistry. It was one of my least favorite classes. When I got to college and took PS1, I was terrified, because I would have to go through the pain I went through in high school all over again. However, this was not the case. I absolutely loved it, and I think a big part of it was because of Gregg Tucci. After taking general chemistry, I had to take organic chemistry. I was intimidated based on what I've heard from upperclassmen. However, I absolutely loved Chem 17. I realized that as I took more classes that were biology, chemistry, and biochemistry, that the tables have turned since high school and I enjoyed chemistry so much more than biology.

- Jen Xu, '19

I always tap into Tucci whenever I can. A calming, joy-filled presence is always appreciated when making decisions/facing the unknown in this concentration. Your advisors are there for you, your professors will accommodate you, and your peers are all going through the same thing— so you will make it!

- Elijah Suh, '22

On Academics:

A lot of learning and community building take place during office hours. Topics that may not have been fully covered in class may come up, and it is always

helpful to hear the questions that your fellow classmates may have about the material. Never be afraid to ask questions – professors and TFs are happy to answer them, and there is no such thing as a dumb question! I have made some of my greatest friends at office hours, and there is nothing more comforting and reassuring than going through a challenging chemistry course with friends by your side.

- Ji Hae Lee, '20

Developing relationships with Professors will give you a sense of where the respective research field is headed and what it takes to do truly innovative work. Their passion will motivate you and the interactions will enrich your undergrad experience.

- David Jaramillo, '16

At the beginning of the semester, mark all office hours and help sessions. They're far more useful than tackling the material yourself.

- Berenger Wegman, '19

Remember to take courses that you are actually interested in, rather than courses that are easy. You generally won't mind the time you spend on a course you are really interested in and will loathe every minute you spend on a boring, but 'easy' course.

- Ted McKlveen '15

If there's an elective being offered that interests you one semester, take it! Also, do not be afraid to go abroad or take random classes that don't count towards the concentration—I ended up having a surplus of extra elective slots senior year. I was worried about getting my concentration requirements out of the way, so I took Chem 160/161 junior year instead of a chemistry elective. However, I wish I'd

done the opposite, as there were many fewer chemistry electives offered my senior year.

- Naomi Reiner '18

I really enjoyed the course work after freshman year! I felt much more prepared for the courses I took and had meet a good group of students to work on problems sets with, developed effective study habits etc. The courses after freshman year were much smaller and more personalized. Second semester sophomore year I took two chemistry/related courses with under 10 people and one with under 30. I got to know my professors much better in these courses and found they were much more relaxed and oriented towards discussion vs. taking notes in a large science center classroom.

- Julia Mundy '06

On Research:

Many professors will allow you to observe their weekly group meetings (as I did during my sophomore year). This is also a great way to learn more about the specific graduate student projects and get a feeling for the atmosphere in the group without/before making a formal commitment.

- Julia Mundy, '06

When you are ready, my advice is to be flexible and persistent. Don't get discouraged if a particular professor does not have space in their lab or is slow to respond to email (in this case, email multiple times and cc the group administrator). Dr. Tucci can also help alert the professor to your interest as well as make suggestions on appropriate labs to look at. I would also talk to as many undergrads and grad students as you can about the lab—ask about how many hours the professor asks for, useful coursework preparation, the general atmosphere, what exciting projects are

currently going on etc. I've had an interview in which the professor specifically asked who in his lab I had spoken to in an effort to gauge my interest!

- Julia Mundy, '06

§5.2 Acknowledgements

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